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THE MICROORGANISM CAUSING EPIDEMIC POLIOMYELITIS[1]

From the facts presented it follows that by employing a specially devised method there has been cultivated from the central nervous tissues of human beings and monkeys the subjects of epidemic poliomyelitis a peculiar minute organism that has been caused to reproduce the symptoms and lesions of experimental poliomyelitis. The microorganism consists of globoid bodies measuring from 0.15 to 0.3 of a micron in diameter, and arranged in pairs, chains and masses, according to the conditions of growth and multiplication. The chain formation takes place in a fluid medium, the other groupings in both solid and fluid media. Within the tissues of infected human beings and animals the chains do not appear.

No statement is ventured at present as to the place among living things to which the

[1] Concluding part of a paper by Dr. Simon Flexner and Dr. Hideyo Noguchi published in the *Journal of Experimental Medicine* for October.

bodies belong. It is obvious that the cultural conditions are those that apply more particularly to the bacteria.

On the other hand, the microorganism is associated with the production of an acute disease in which suppuration does not form a prominent part. No special attention at the present time has been given to the solution of the question as to whether the microorganism actually belongs to the bacteria or to the protozoa. In the manner of evolution of the symptoms, and in the appearance of the lesions, the experimental disease caused by the inoculation of the cultures resembles that produced by the virus of poliomyelitis as ordinarily employed. The central nervous organs of monkeys infected with the cultures bear preservation and glycerinization as do the infected human tissues, or the monkey tissues infected directly from human tissues. Cultures to which glycerin is directly added survive in the refrigerator at least eight days.

The microorganism passes through Berkefeld filters and the filtrates yield upon recultivation the particular microorganism contained within the filtered culture. Moreover, Berkefeld filtrates prepared from the nervous tissues of infected human beings and monkeys yield also in culture the identical microorganism.

By employing a suitable staining method the microorganism has been detected in film preparations and sections prepared from human nervous tissues, and from the corresponding tissues of monkeys inoculated with the usual virus or with cultures or filtrates prepared from monkeys previously injected with cultures. From all the infected materials mentioned, irrespective of the manner of their origin, the microorganism has been recovered in cultures. As would be expected it is more uniformly recoverable from the original nervous tissues than from filtrates, and doubtless for the reason that in the former it exists in greater abundance.

To obtain the initial culture is difficult, and this irrespective of whether the tissues submitted to cultivation have come immediately from man or from monkeys previously inoculated with the ordinary virus or even with the cultures. Once the microorganism adapts itself to a parasitic state it is developed with greater difficulty under saprophytic conditions. Whenever the nervous tissues have been shown to be infectious, the microorganism has been recoverable, notwithstanding long preservation and glycerination. In other words, infectivity of the nervous organs and the presence of the microorganism exist together. It has indeed happened that a specimen of infected nervous tissue has at the first attempt not yielded the initial growth, although it has yielded it upon the second attempt. Persistence will usually lead to a successful cultivation, provided no technical fault is committed. An important factor in the technique of cultivation is the sample of ascitic fluid. Not all samples are suitable, and a preliminary test is necessary, using for the purpose a growing culture, in selecting samples for culture purposes. Once a suitable ascitic fluid is obtained it should be carefully husbanded in the refrigerator. Even with this precaution failure may still occur. In such an instance repetition, using the same materials but in two series, one of which is prepared for enclosure in the anaerobic jar, while the other is allowed to remain outside, may yield the desired result; or the result may come on a second trial that appears to be an exact repetition of the first.

Only the exceptional cultures possess the degree of pathogenicity sufficient to cause specific infection, and the production of experimental poliomyelitis. A pathogenic strain may be effective at different and even remote generations, and a non-pathogenic strain may lack pathogenicity even in the second generation. This important fact indicates strongly that the pathogenic effect is not due to mere mechanical carrying over into the cultures of an invisible parasite or virus with which the cultivated microorganism is accidentally associated. If such accidental association were the cause of the experimental disease produced by the cultures in monkeys, it would display itself preferably in

the first generations and without reference to the strain of the visible microorganism. On the other hand, in this fluctuation of pathogenicity the cultures imitate the action of the virus as contained in human materials, namely, nervous tissue, secretions from the nasopharynx and intestinal washings, in which the virus, either known or believed to be present, may yet fail to be demonstrated by reason of the want of infectious power for monkeys or for the particular monkey inoculated in a given instance. Moreover, it is a common experience in bacteriology to find even among the ordinary bacteria lack or rapid loss of virulence among saprophytic cultures, while virulence is not only retained, but may be increased in rapid passages from animal to animal.

In view of these considerations it would appear that an etiological relationship has been shown to exist between the cultivated microorganism and epidemic poliomyelitis as it occurs in human beings or in monkeys. There remains merely a single other possibility, already indicated, namely, that two factors are present in the cultures, the one an invisible because ultramicroscopic organism, the other the globoid bodies described. On this basis it would have to be supposed that the former but hypothetical factor is the essential agent of infection. As against this supposition it may be urged that an instance of symbiosis of this nature is not known to animal pathology. Regarding the cultivated minute but visible microorganism itself, it may be held on the basis of the data presented that it fulfills the conditions hitherto demanded for the establishment of causal relation between an extraneous parasite and a specific disease. The microorganism exists in the infectious and diseased organs; it is not, as far as is known, a common saprophyte, or associated with any other pathological condition; it is capable of reproducing, on inoculation, the experimental disease in monkeys, from which animals it can be recovered in pure culture. And besides these classical requirements, the microorganism withstands preservation and glycerination as does the ordinary virus of poliomyelitis within the nervous organs. Finally, the anaerobic nature of the microorganism interposes no obstacle to its acceptance as the causative agent, since the living tissues are devoid of free oxygen and the virus of poliomyelitis has not yet been detected in the circulating blood or cerebrospinal fluid of human beings, in which the oxygen is less firmly bound; nor need it, even should the microorganism be found sometimes to survive in these fluids.

SCIENTIFIC NOTES AND NEWS

At the celebration of founder's day at Lehigh University, on October 3, the degree of doctor of laws was conferred upon Dr. Mansfield Merriman, from 1878 to 1907 head of the department of civil engineering, and on Professor Edward H. Williams, Jr., head of the department of mining and geology from 1881 to 1902.

Professor Eliakim Hastings Moore, head of the department of mathematics of the University of Chicago, was recently elected by the council as a corresponding member of the British Association for the Advancement of Science.

Dr. Arthur Shipley, professor of zoology and master of Christ's College, of Cambridge, will make one of the addresses at the formal opening of the graduate college of Princeton University, on October 22.

Dr. A. F. Blakeslee, who has been spending a year's leave of absence in research work in the Carnegie Station for Experimental Evolution at Cold Spring Harbor, L. I., has returned to the Connecticut Agricultural College, Storrs, Conn., where he is in charge of the department of botany.

Last summer the U. S. Weather Bureau, in cooperation with the Smithsonian Institution, made a series of balloon ascensions in southern California, with Mr. W. R. Gregg in charge of the field party. The latter part of July was spent at Catalina Island, and the first twelve days of August on the summit of Mount Whitney.